TECHNICAL FIELD OF THE INVENTION

The present invention is related to a method and a device for precision and passive alignment such as a precision and passive alignment technology for low cost array fibre access components.

BACKGROUND OF THE INVENTION

A combination of microstructure technologies for silicon and polymer has been used to fabricate benzocyclobutene (BCB) waveguide FTTH array components with an MT-interface. Passive alignment structures have been used for both laser arrays, diodes and optical interfaces.

SUMMARY OF THE INVENTION

The broad band society demands substantially increased capacity in the telecommunication network. Today there is an unacceptable high cost for the components in the deployment of the optical single mode fibre to the end user. To reduce the cost the efforts has to be focused on array technology, passive alignment and plastic encapsulation.

The following technologies in a defined combination and sequence are the prerequisite to realize the low cost FTTH component described in hereinafter: Silicon micromachining, indiumphosfide (InP) laser diode array technology, benzocyclobutene (BCB) waveguides, passive alignments of laserdiode arrays to waveguides by self-aligning solder bumps, passive alignment of waveguide to an optical MT interface - micro replication technology and plastic encapsulation.

A laser carrier is passive aligned to an MT-interface using alignments structures on a low cost replicated carrier. The laser carrier is based on a self-aligned semiconductor laser,

flip-chip mounted on a silicon substrate with planar polymeric waveguides. The concept for alignment according to the invention is shown in figure 1 with a front view of a laser carrier mounted on a polymeric carrier.

The novel concept for a low cost array laser component has thus been evaluated. It may be built on a passive alignment technology between a laser and a waveguide and between waveguides and an optical MT interface. It is feasible that the found process and the found process sequence will make it possible in the future to work and to meet the requirements for manufacturing cost effective commercial components with good optical properties.

The invention will now be described in more detail with reference to a preferred embodiment therof and also to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a front view of a laser carrier mounted on a polymeric carrier with the concept of an alignment according to the invention.

Figure 2 is a top view of a laser carrier with alignment trenches adapted for the carrier structure according to the invention.

Figure 3 is a front view of the polymer carrier according to the invention showing alignment structures in a mould insert and the formed polymeric carrier.

DETALED DESCRIPTON OF A PREFERRED EMBODIMENT

A laser carrier 1 comprises an edge-emitting SM laser array 2 passive aligned to the waveguides 3 on the carrier using AuSn soldering bumps, se figure 2. This method of alignment has earlier been shown to give single mode precision, see reference /1/ and /2/. The alignment is achieved by the

surface tension that is created of the bumps in the melted phase. The planar waveguides 3 of for example BCB, see reference /3/, on the silicon substrate conduct the light from the laser array 2 to the edge of the carrier 1, enabling a laser component without pigtail connection and with future waveguide functionality to be integrated. For aligning the carrier 1 to an MT-interface alignment trenches 4 are etched, see figure 2, into the outer parts of the carrier 1 preferably made by silicon.

The laser carrier 1 is then placed upside down on a polymeric carrier 5 and passively positioned to an MT-interface by fitting the alignment trenches 4 on the laser carrier to vertical alignment structures 6 and the waveguides 3 to horizontal alignment structures 7 on the polymeric carrier, see figure 1. Polymeric carriers are preferably made by using replication technique, based on transfer moulding with micro structured silicon as a mould insert 8, see figure 3 and reference /4/. The mould insert comprises v-grooves of different sizes for the MT-interface, the vertical alignment and the horizontal alignment for later creating the vertical alignment structures 6 and the horizontal alignment structures 7 in the polymeric carrier. In order to make room for the laser array a cavity can be formed behind the alignment structures in the polymeric carrier. This is preferably done using a bonded building block on the mould insert. Quartz filled epoxy is used as polymer in order to achieve dimensional control and low thermal expansion of the replicated structures, see reference /4/ and /5/. MT guiding holes 9 in the replicated carriers, see figure 1, are made by placing the MT-guiding pins 10 on the mould insert during the replication step.

A lead frame may then be mounted on the backside of the laser carier and connected to the electrodes by wire bonding. This is done before the laser carrier is fixed to the polymer

carrier by gluing. Finally, this package is encapsulated using transfer moulding and polished to achieve optical finish at the waveguide edge.

The laser array can have four laser channels, where signal electrodes can apear on the epitaxial side and be connected to the carrier when the laser array is flip-chip mounted. The common ground electrode is wire bonded to the laser carrier.

The laser carrier was manufacturated using standard micro structuring technique with litography and dry etching on silicon. Electrodes were made by e-beam evaporation of Ti/Pt/Ni/Au and a lift-off technique. Gold and tin can then be electroplated through a photoresist mask as soldering bumps. The planar BCB waveguide was built up by under- and overcladding layers, and in between a waveguiding core, se reference /3/. All these layers were deposited on the silsicon substrate by spinning deposition and the pattern of the waveguiding core was made in a lithography step. The end surface of the waveguide was also dry etched, thus creating a sharp edge of the waveguide. This was done in order to get good coupling efficiency from the laser into the waveguide core. Finally, alignment trenches were etched into the substrate using DRIE (Deep Reactive Ion Etching) with oxide as masking material.

Silicon wafers of (100) orientation was anisotropically etched in KOH (30 vol.%), for manufacturing the mould insert. Since the v-grooves for the MT-guiding pins consists of two levels, two separate litography steps were used with Si oxide and Si nitride as masking material. First the wider MT-structures were etched with nitride as masking material. After removing the nitride, the rest of the structures were etched with an underlying oxide mask. In order to create the building block, another silcon wafer was fusion bonded on top of this wafer. The building block structures were then etched out from this bonded wafer. All structures in the mould

insert were compensated for a dimensional shrinkage of 0,629% of the polymeric material, see reference /4/.

The optical properties of the laser module can be tested with an integrating sphere and the IP-curve can be recorded for each individual channel.

The total shrinkage of the replicated structures after the transfer moulding was found to be about 0,69% when measuring the structures on both mold insert and replicated carrier with a profilometer.

It will be understood that the invention is not restricted to the aforedescribed and illustrated exemplifying embodiment thereof, and that modificatons can be made within the scope of the following claims.

REFERENCES

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